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OPTIMUM DESIGNS FOR SECOND ORDER PROCESSES WITH GENERAL LINEAR --ETC(U)
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OPTIMUM DESIGNS

Research was done in statistics in the area of optimal experimental design. The particular facet under investigation was that of optimal regression designs when the observations are stochastic processes. The initial objectives of the research were:

A) specialization of some existing results to the case of data which are solutions to initial value random differential equations, and

B) further investigation of some of the technical difficulties involved in the characterization of optimal designs when the observations are stochastic processes.

Subsequently another general area was added,

C) characterization of some robust optimal designs.

Within area A) detailed study was made of the estimation of the value of a linear functional operating on an unknown forcing function. The variance of the minimum variance unbiased estimator of this value was shown to be independent of the order and coefficients in the collection of differential operators

$$L = D^m + a_{m-1}D^{m-1} + \ldots + a_o I.$$

This result was put to advantage. A method was developed for selection, given the aspect of the forcing function to be measured, of the differential operator leading to a simple estimator. Results were phrased in terms of the design of measurement systems. The methods of selection of the best experimental design developed for the general linear model were next specialized to the case of the mean forcing function under the partial control of the experimenter.

In area B) an attempt was made to develop alternative characterizations of optimality. An extremely powerful sufficient condition has been found which in the finite dimensional parameter space setting is also necessary. Also, in the infinite dimensional case can one always assume the parameter space is a Hilbert space? This question has been partially answered in the affirmative.

In area C) a robust estimator studied by Paul Speckman at University of Oregon was shown to apply in cases in which the observations are stochastic processes. Optimal designs using this estimator were successfully characterized.

In each of the areas above good progress has been made toward the development of a reasonably complete arsenal of techniques. However, gaps remain especially in the areas of estimation of the entire mean function and in characterizations of more globally optimal designs.

The results described above will appear, in the following papers. Hopefully they will appear in the journal indicated.

1) "Optimal Designs for Random Differential Equations with Applications to the Design of Measurement Systems" submitted to Journal of Multivariate Analysis.

2) "Admissibility of the Natural Estimator of the Mean of a Gaussian Process" submitted to Journal of Multivariate Analysis.

3) "Optimal Designs for Speckman's Estimator" to be submitted to SIAM Journal of Optimization and Control.

Support to the following graduate students was extended under the contract.

Bruce Lynskey - June 18-September 1, 1979
Elaine M. Hubbard - June 23-September 6, 1980

Ms. Hubbard recently completed a doctoral thesis entitled "An Algorithm for Finite Dimensional Approximations of Solutions to Infinite Dimensional Problems" under the direction of Professor J. J. Goode. It is anticipated that she will receive her doctorate in the Fall of 1980.

Various aspects of the research activity were presented in the following talks presented by M. C. Spruill:

1) "Optimum Designs for Random Differential Equations" presented at the 166th meeting of the Institute of Mathematical Statistics in New Orleans, Louisiana.

2) "Optimal Designs Using Speckman's Minimax Linear Estimator" presented at the 174th meeting of the Institute of Mathematical Statistics in Ann Arbor, Michigan.

3) "Optimal Designs for Second Order Processes" presented as a series of 5 one hour lectures at Queen's University in Kingston Ontario, Canada, November 3, 4, and 5, 1980.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

In the experimentation of any of the sciences, physical, biological, or social there arise situations in which the exact conduct of a specified experiment is under the control of an experimenter. The experimenter must therefore make a decision. Where the conduct of an individual experiment may be costly or where there are a large number of possible experiments a premium is placed upon the quality of this decision. This research was concerned with the selection of the proper experiments when the data are "time" recordings. Of special interest was data which arise as solutions to linear white noise random differential

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) equations. Approximately optimal designs were effectively characterized for this case. Similar characterizations were shown to hold for partial differential operators and random fields. Work was also begun on the identification of experiments which are robust against departures from the assumed model. Results were obtained for both scalar and "time" recording data.